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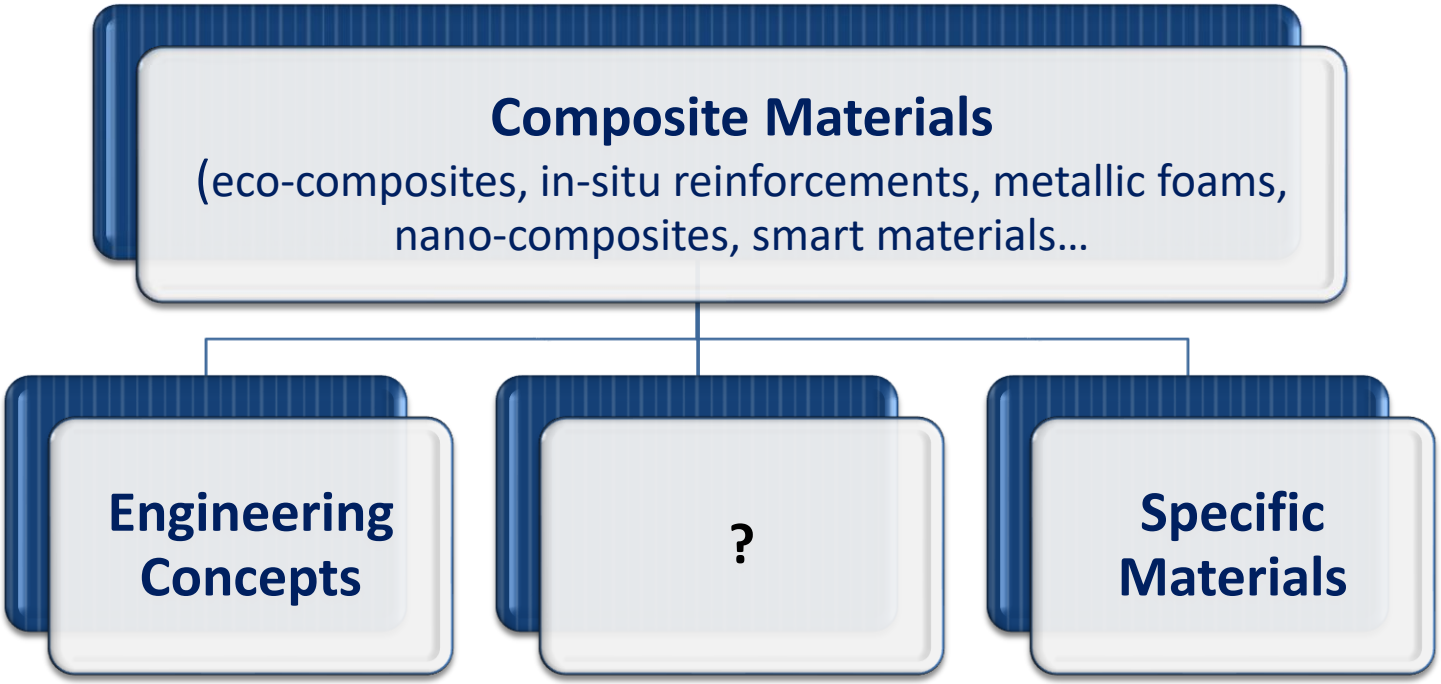
BASIS OF THE COMPOSITE MATERIALS AND THEIR PRODUCTION TECHNOLOGIES

Polymer composites - Fibre reinforced plastics

- high performance materials
- for structural applications where high strength-to-weight and stiffness-to-weight ratios are required.
- requirements – multidisciplinary: mechanics, chemistry, physics, and strength of materials.

Polymer composites - Fibre reinforced plastics



Main focus would be given on composite materials since we can interfere with their structure and tailor their properties in accordance to the end use requirements.

Fibre reinforced plastics: matrices, reinforcements

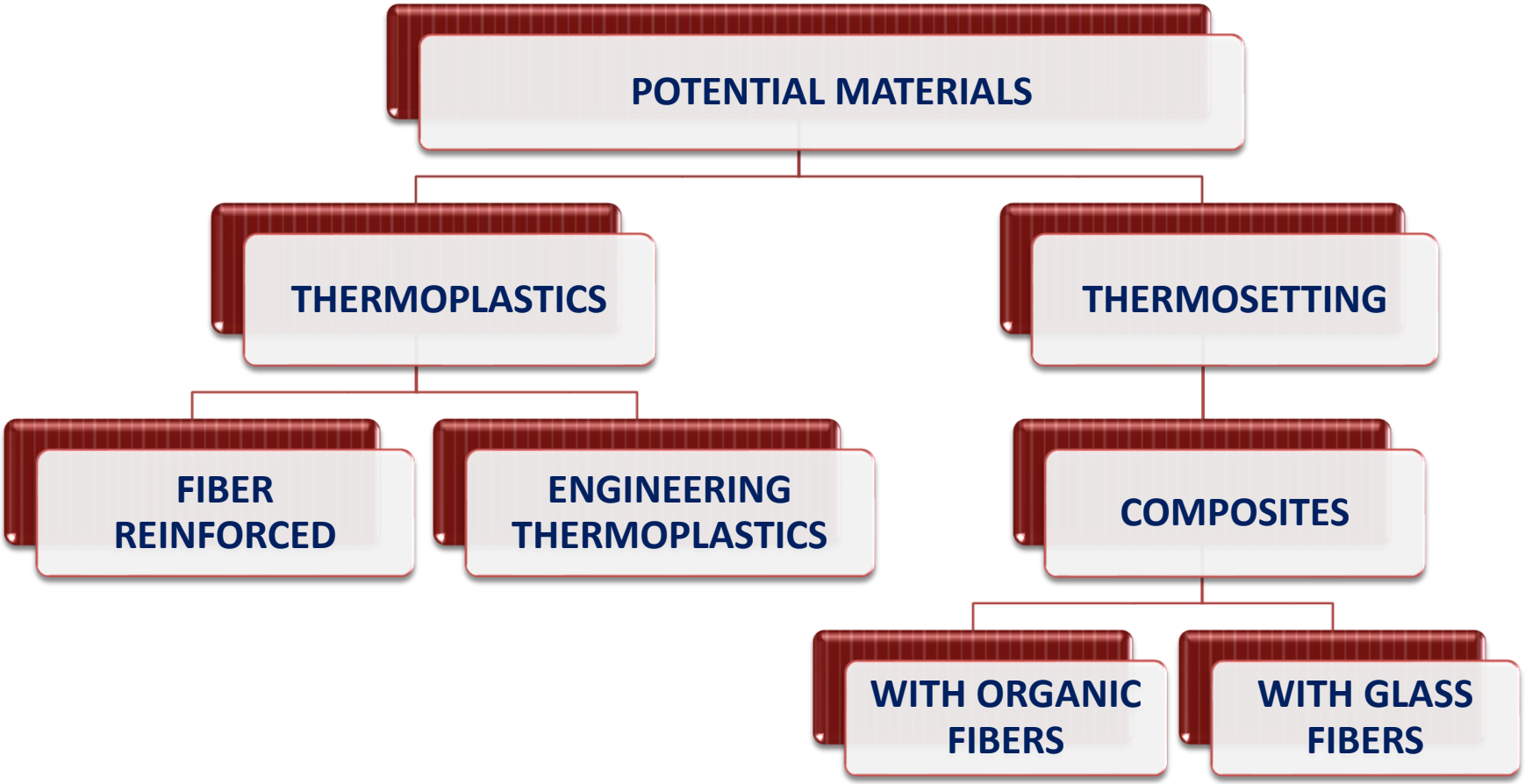
Thermoplastic polymers:

- ✓ *can be reformed and reshaped by simply cooling and heating,*
- ✓ *flexible and reformable,*
- ✓ *have lower stiffness and strength*
- ✓ *poor creep resistance at high temperature, and*
- ✓ *are more susceptible to solvents*

Thermosetting polymers:

- ✓ *cannot be remelted and reformed.*
- ✓ *offer high rigidity, thermal and dimensional stability, high electrical, chemical and solvent resistance.*

Fibre reinforced plastics: matrices, reinforcements



Engineering plastics are used "as they are" with no possibility to interfere with their structure i.e. their properties. In fact, all these are commercial products.

Fibre reinforced plastics

- **Research and development - have grown rapidly**
- fibers and matrix materials,
- fabrication process.

- **Advantages over other traditional construction materials:**
- high tensile strength to weight ratio,
- ability to be molded in various shapes.

- **Application:**
- upgrading existing structures and
- building new ones which can be applied to various types of structures.

Raw materials

Thermosetting resins

- *Epoxy resin for laminating*
- *Epoxy resin for filament winding*
- *Phenolic resin*
- *Vinyl ester*
- *Polyester resin for pultrusion process*

Accelerator for resins

Hardener for resins

Thermoplastic resins

- *Polypropylene (PP)*
- *Poly lactic acid (PLA)*
- *Polyvinyl butyral (PVB)*
- *Polycarbonate (PC)*
- *Polyethylene (PE)*
- *Nylon*

Raw materials

Fabrics used for laminating

- *Glass, Aramid, Carbon fabric*
- *Woven roving fabric*
- *Cotton fabric*
- *Nonwoven (mat) material*

Rovings used for filament winding

- *Glass*
- *Carbon*
- *Polyester*
- *Aramid*

Natural fibers/fillers

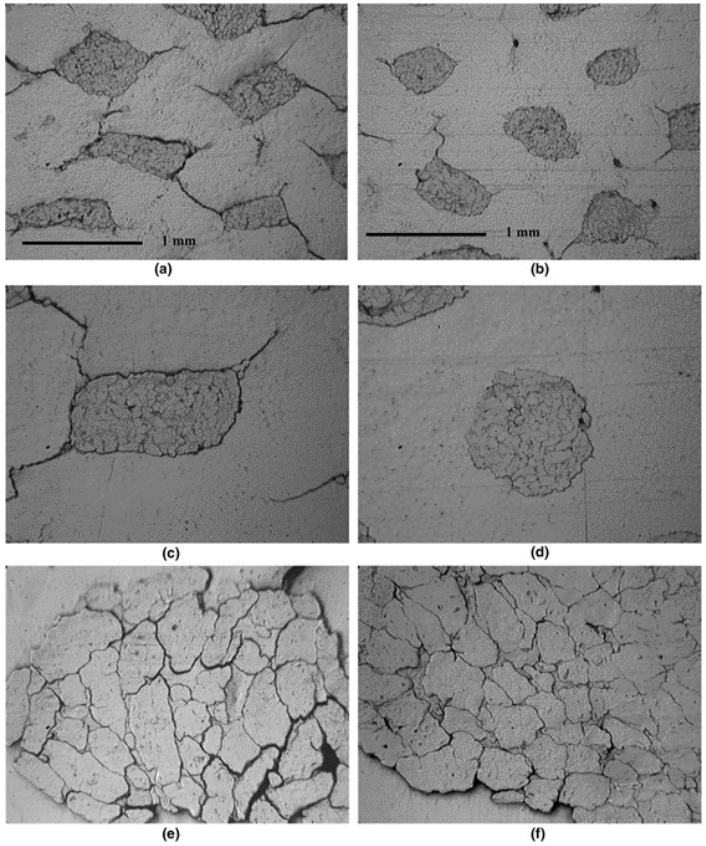
- *Kenaf*
- *Cotton*
- *Rice hulls*
- *Paper*

Interface

Fiber/matrix interface region-
key factor determining the load transfer

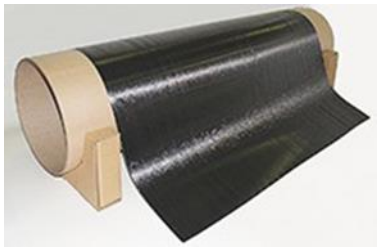
Approaches to enhance fiber/matrix adhesion strength:

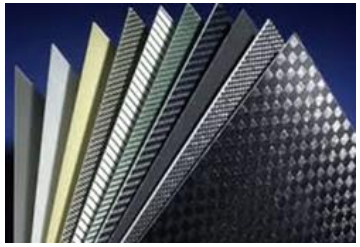
- polymer matrix modification (by using compatibilizing agent (CA))
- fiber (surface) modification
- polymer and fiber modification
- processing conditions/new technologies



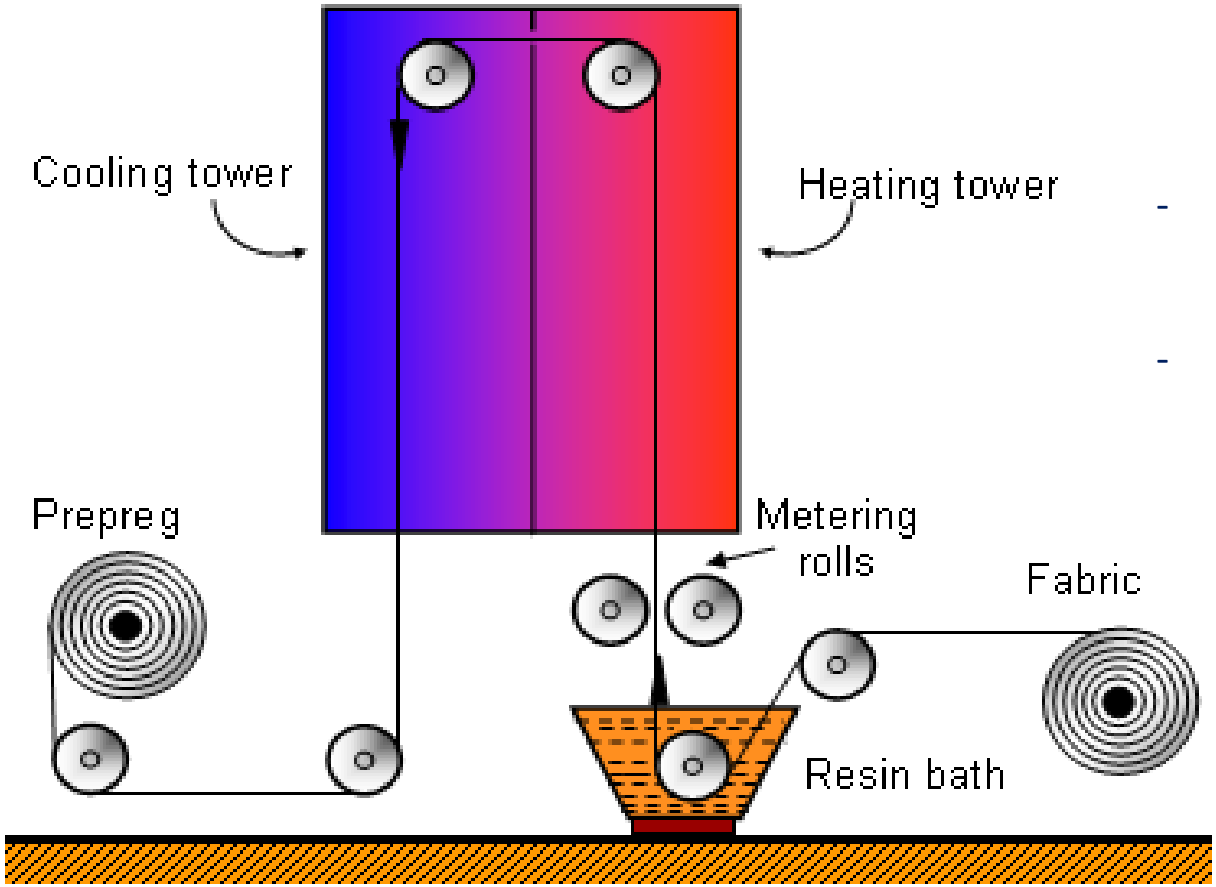
Technology for composite production

- Impregnation – applicable to fabrics only
- Laminating (molding) –applicable to prepregs only
- Filament winding –applicable to rovings only
- **Compression molding – open and close mold**
- **Structural Reaction Injection Molding (SRIM)**
- **Reinforced Reaction Injection Molding (RRIM)**
- **Extrusion**
- **Reactive blending**
- Pultrusion





Impregnation process



- wetting of fibers with the matrix - lake a transparent film
- partly melted and in phase suitable for processing

The final product is prepreg (pre-impregnated fabric with resin) which is considered a semi-finished product.

Compression molding (CM)

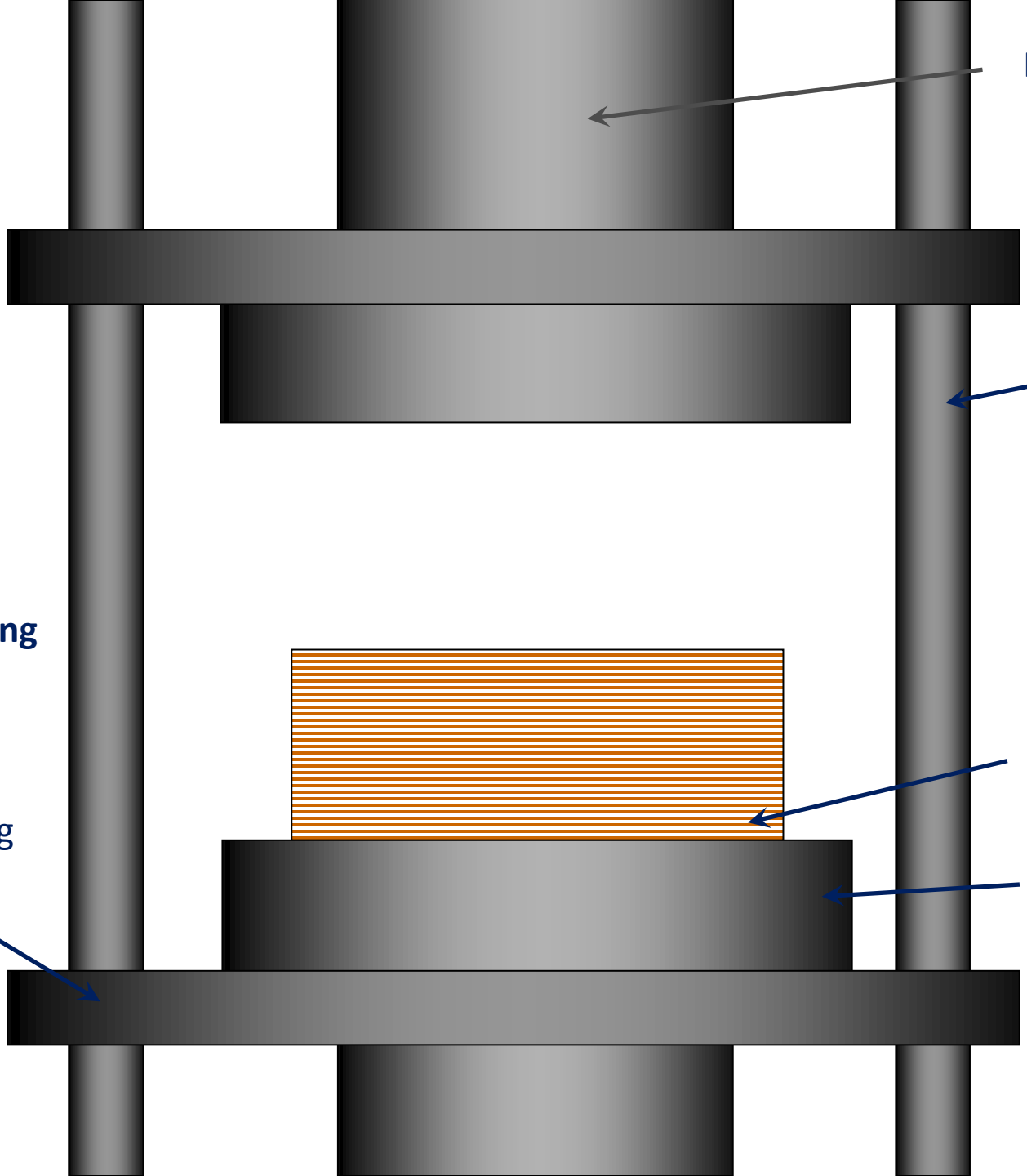
- *major method for processing plastics*
- *high pressure process*
- *applying heat and pressure*
- *in matched or open dies*
- *main processing method for thermoset plastics*
- *also be employed to process thermoplastic materials*
- *compression molding press*
- *composite plate*
- *advantages: short cycle time, high production rate and excellent surface finishes*

Materials used for CM:

- SMC (Sheet Molding Compounds)
- BMC (Bulk Molding Compounds)
- Pellets/granules

Matched die technique

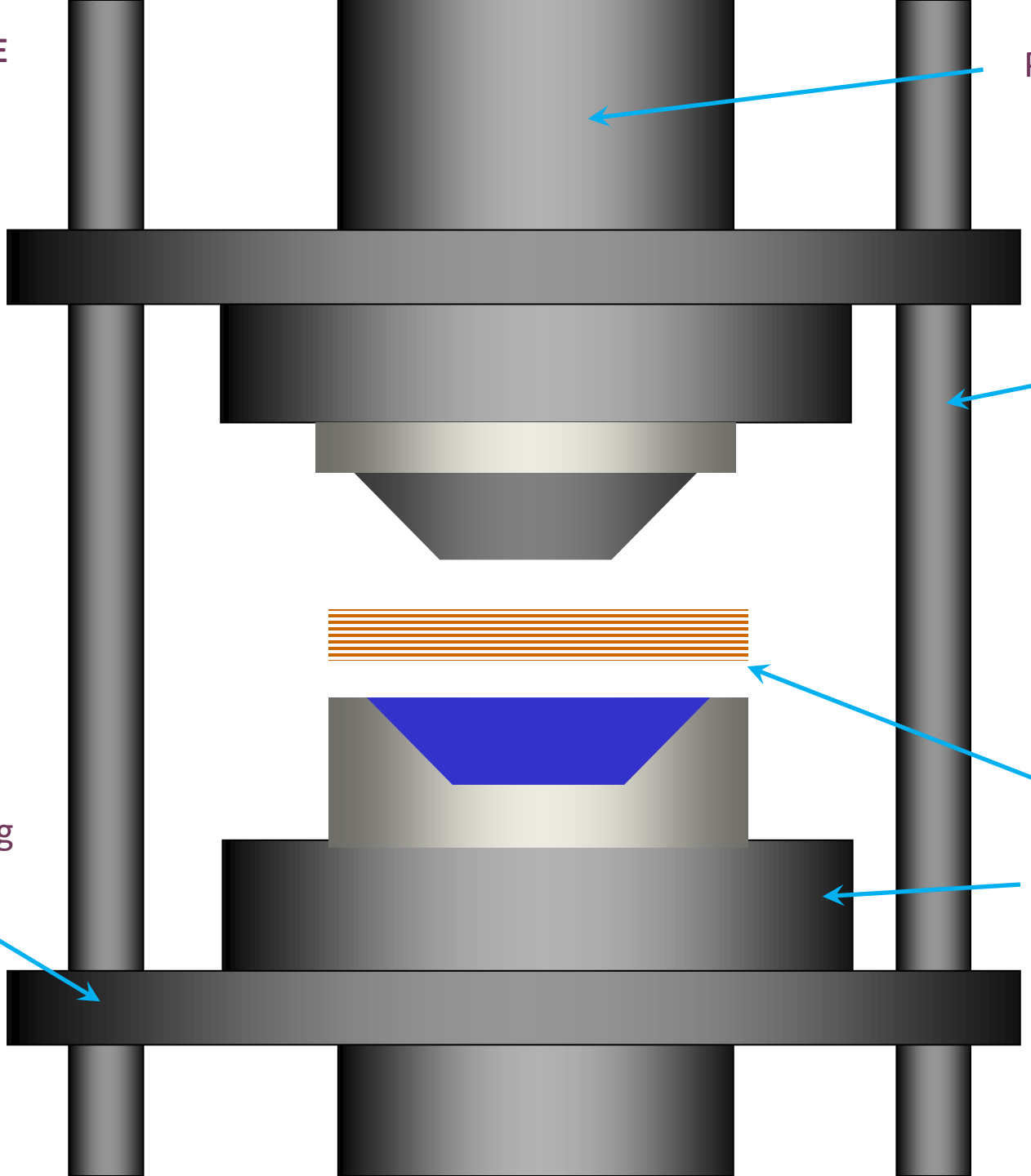
SMC



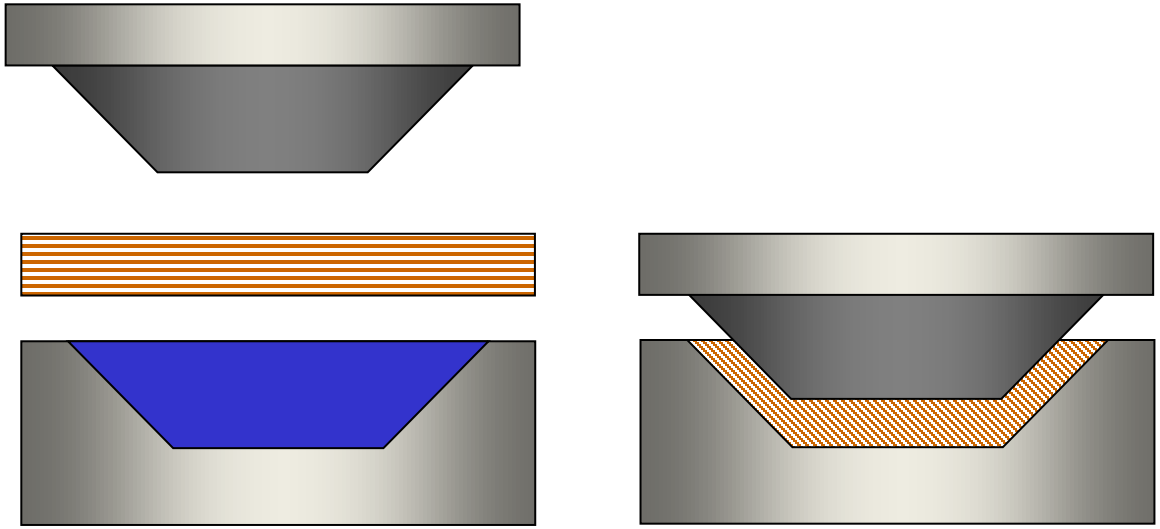
No mold,

single-opening press

MATCHED DIE TECHNIQUE



Matched die molding



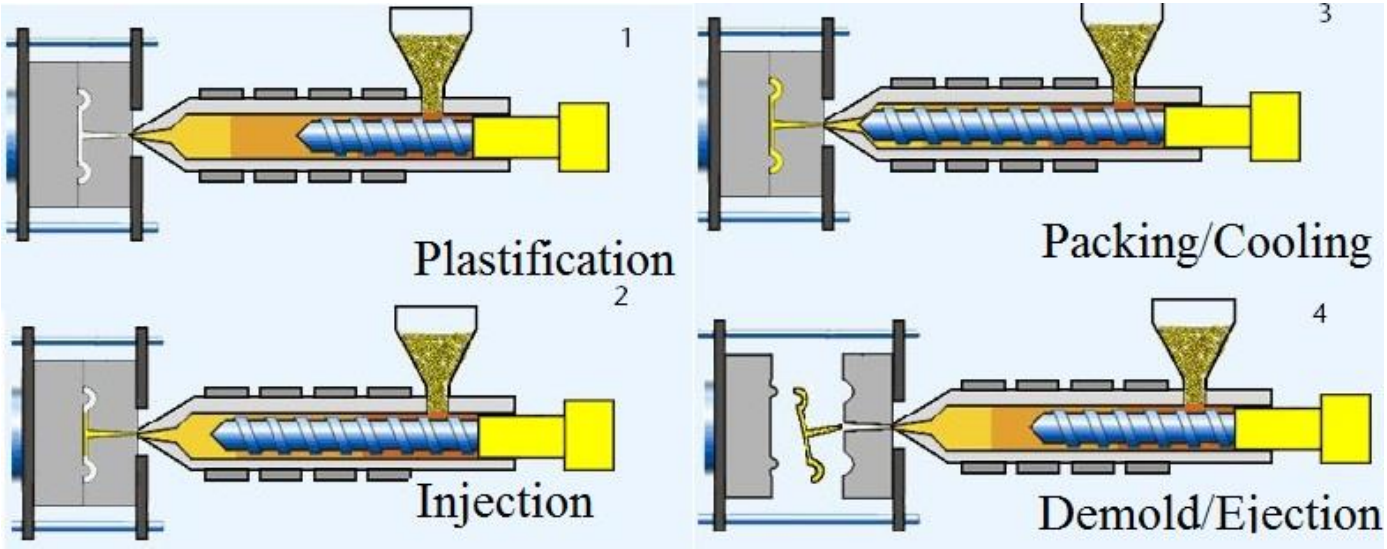
Open mold

Closed mold

Appropriate for BMC , pellets and for SMC (simple shapes only)

Injection molding technique

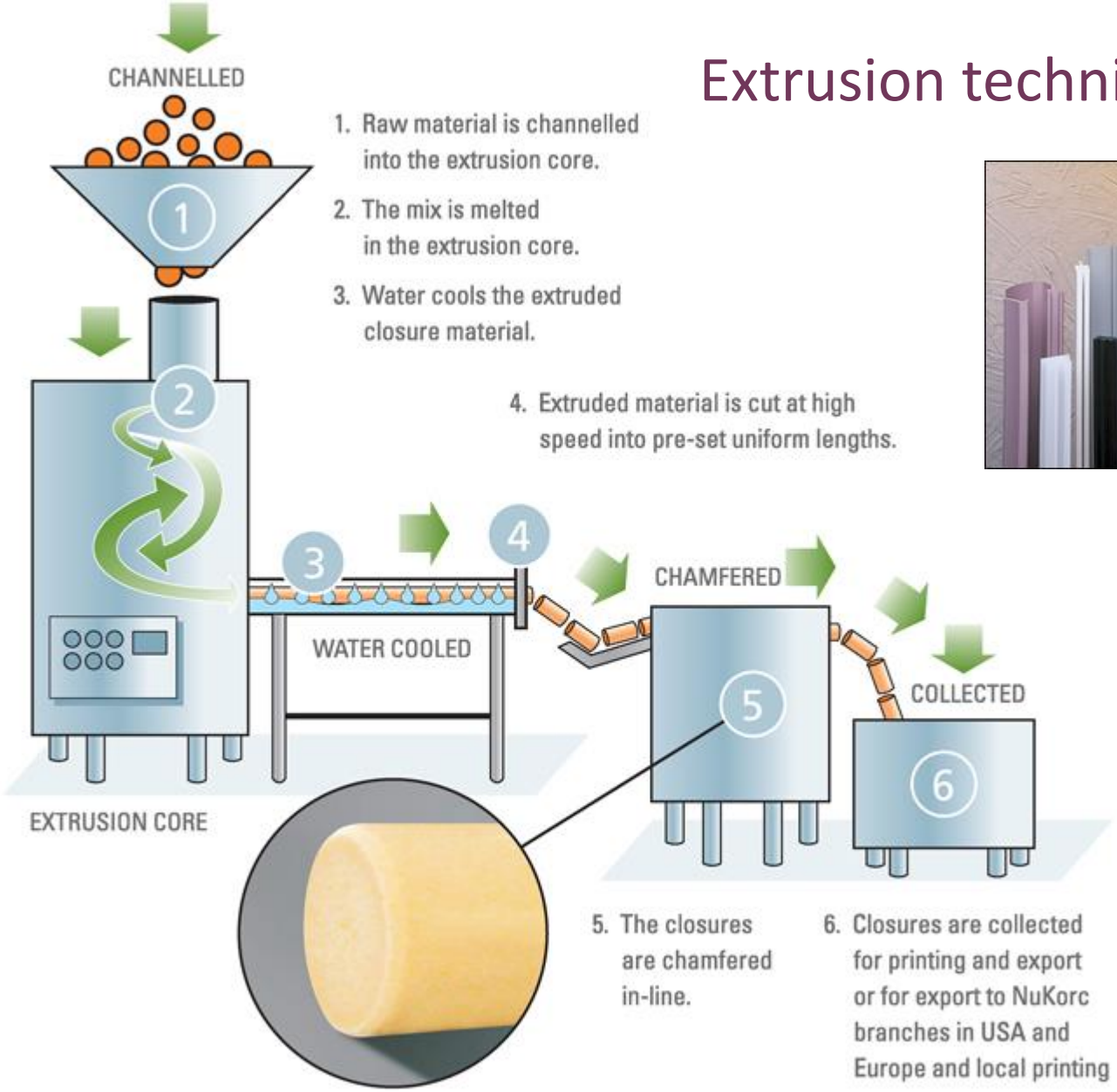
Processing method for the manufacture of reinforced thermoplastic polymers



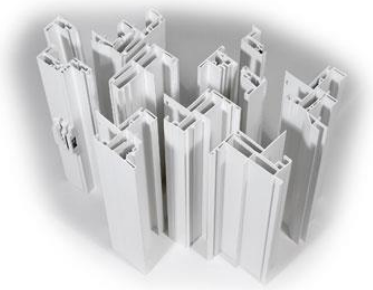
Processing cycle of conventional injection molding process

- *thermosetting, thermoplastic, fiber reinforced thermoplastics*
- *in many ways*
- *the most widely used*
- *length of fibers is short (about 0.2–0.4 mm)*
- *manufacturing a variety of parts*

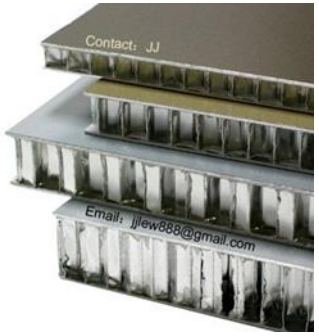
Extrusion technique



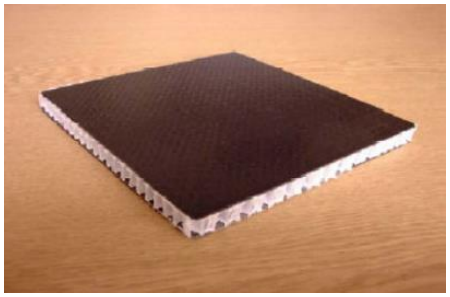
1. Raw material is channelled into the extrusion core.
2. The mix is melted in the extrusion core.
3. Water cools the extruded closure material.
4. Extruded material is cut at high speed into pre-set uniform lengths.
5. The closures are chamfered in-line.
6. Closures are collected for printing and export or for export to NuKorc branches in USA and Europe and local printing



HYBRIDS



Application: for construction of houses, schools, offices, sports halls, factories…..



PP-honeycomb core for NFR-composite sandwich panels

Thank you

for your attention!